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OF RUSSIAN ACADEMY OF SCIENCES.

DEPARTMENT OF KINETICS OF CHEMICAL
AND BIOLOGICAL PROCESSES.

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The Department of Kinetics of Chemical and Biological Processes of the Institute of Chemical Physics of the Russian Academy of Sciences was founded by Academician N.M.Emanuel in 1965. Scientists of different fields - physical chemistry, organic chemistry, biophysics, biochemistry - were invited to work at the Department. The main task of such association, along with the continuation of investigations of kinetics and mechanisms of chemical reactions (oxidation of hydrocarbons, polymer degradation etc.) traditionally carried out by the Institute, was to develop some methods of chemical kinetics with reference to complex biological processes; to study the role of free-radical reactions in damage of not only chemical but also biological polymers as well as regulation and development disturbances of pathological processes in living organisms and therefore to use inhibitors-antioxidants for inhibition of free-radical reactions which lacked in normal metabolism. In recent years (1989-1994), considerable progress has been achieved in the research dealing with the application of results of the studies of biological processes in chemical practice - the so-called biomimetic investigations.

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Popov A.A., Head, Dr. of Chem., Prof.

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Microreactors in the macromolecular systems: structural organization, properties and using during photochemical processes realization.

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Tarasov V.F., Head, Dr. of Chem.

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Kovarskii A.L., Head, Dr. of Chem.

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Zaikov G.E., Head, Dr. of Chem. Prof.

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Nature and kinetics of mechanodestruction in polymer melts. Investigation of organic compounds oxidation-destructive decomposition mechanisms and concepts of their management. New means of water purification and disinfection under field and home conditions.

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Investigation of mechanisms of high-temperature pyrolysis and combustion reactions of network polymethacrylates.

Rubailo V.L., Head, Dr. of Chem.

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Gumargalieva K.Z., Head, Cand. of Chem.

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SSTP "New Materials".

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Kinetics of tumor growth and physico-chemical changes in membranes of immunocompetitive cells.

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- Regulators of plant growth.
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- Ethylene biosynthesis.
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Burlakova E.B., Head, Dr. of Biology, Prof.

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- Ultra-low doses of chemical compounds and low-intensity physical factors.
- Effect of chemical compounds on experimental cataracts.
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- Membrane lipids and data storage.

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Ostrovsky M.A., Head, Dr. of Biology, Acad.

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Sharpatyi V.A., Head, Dr. of Chem., Prof.

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- Changes in DNA and membranes during malignant diseases of blood system.
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Kuznetsov V.A., Head, Dr. of Physico-mathematical science.

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Komissarov G.G., Head, Dr. of Chemistry, Prof.

Photovoltaic properties of photosynthetic pigments and their analogues.
Physiological activity of vegetable objects.
Synthesis of regulators of plant growth.
New methods of evacuating environmental contamination.
Photosynthesis mechanism and its modelling.

Gorbacheva L.B., Head, Dr. of Biology, Prof.

Post-radiation rehabilitation in Drosophila generation series.
Medicinal resistance to antitumor drugs.
Secondary structure of mammalian DNA at terminal phase of aging .

Pelevina I.I., Head, Dr. of Biology, Prof.

Combined effect of radiation and chemical compounds.
Consequences of nuclear disasters - groups of risk.
Adaptive response.
Cytogenetic changes in human lymphocytes.
Remote consequences of radiation.

Pulatova M.K., Head, Dr. of Phys-Math., Prof.

Specific effect of radiation at small doses.
Retrospective evaluation of doses and degree of radiation damage.
Molecular mechanisms of action of biologically active substances .
Molecular mechanisms of protein and enzyme functioning.

Vanin A.F., Head, Dr. of Biology, Prof.

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Biological role of nitrogen oxide.

Vasilieva S.V. , Head, Dr. of Biology.

Genetic effects of chemical compounds at small doses.
Genetic aspects of ecology.
Genotoxicity of new drugs.
Mutagenesis and antimutagenesis under chemical actions on cell.

Barsel V.A., Head, Master of Medicine

Studies on pharmacological properties of new medicinal forms.
Antitoxic action of antioxidants.
Diagnostics and prognosis of internal diseases course.
Complex therapy of diseases.

Kaplan E.Ya., Head, Dr. of Medicine, Prof.

Biological testing of sorbents.
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Genome reorganizations in Eukariotes.

Repeated sequences of Eukariote genomes under prolonged mutagenic action.

Small doses of ionizing radiation in adaptive response system.

Sapezhinsky I.I., Head, Dr. of Chem.

Drugs as acceptors of free radicals.

Glucolysis enzymes of brain cells.

Photoecology of ozone holes.

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Grosberg A.Yu., Head, Dr. Phys.-Math., Prof.

Liquid crystals and mezophases.

Statistical theory of systems with memory and fixed organization elements.

Neuron networks.

Statistical physics of macromolecules.

L'vov K.M., Head, Dr. of Biology, Prof.

Chemical analysis of ATP in oxidative phosphorylation.

Destructive changes in proteins.

Automated spectroscopy of bioenergetic processes in biostructures.

1. Health hazard assessment.

The Lipids Membranes Mechanisms of Recording and Storing Biological Information.

Arkhipova G.V., Burlakova E.B., Krotova I.L.

There are experimental evidence of mechanisms of recording, storage and reproduction of information both on the level of organism and on the level of membrane models. The base of these processes are the structural liquid - crystalline transitions in lipid bilayer of cell membrane under the influence of electromagnetic fields and temperature. Employing the PMR, ³¹P- NMR, X-ray studies it may be shown that nootropic species improved the processes of memoirs and studying, the elementary intellect activity of animals and men, influent on the transition of lipid bilayer from lammeliar to hexagonal phase of liquid - crystalline state of membrane lipids. This agents also promote the decreasing of thickness of synapse membranes and increasing the rate of neuromediatoric transmission.

Geomagnetic Field Variations - Factor Modulating Human Organism State in High Latitudes (In cooperation with S-Petersburg's University)

Belisheva N.K., Konradov A.A.

1. Polar and near-polar regions are known to have strongly variable environmental factors which negatively affect the health status among residents of the said areas.

2. Geomagnetic field (GMF) variations can be one of the sources causing desynchronosis of biological rhythms, organism disadaptation and pathology development.

3. The unique experiments are performed to evaluate the effect of local GMF variations on human organism using the combined geophysical and medico-biological data.

4. Analysis of the dependence of organism basic systems on GMF variations has revealed that 99.6% of examined persons are sensitive to changes in these or those GMF parameters.

5. GMF variations are shown to strongly modify human brain functional activity causing psychoparadoxical responses in certain cases.

6. Various organism systems are shown to exhibit selective sensitivity to some GMF parameters.

7. Physiological parameters which are most sensitive to GMF variations are determined.

Computer recognition methods for analysing small populations, characterized by the great number of variables and missing values.

Kuznetsov V. A., Ivshina A.V., Kuznetsova A.V.

We have developed a novel pattern recognition multi-step procedures based on the syndrome approaches and on the statistical-based voting algorithms. Computer versions of the method were realized by computer for making decisions about objects which belong to small populations with relatively small difference of most of the variables. These programs permit us to effectively select the high-informative combinations of the variables, to find integral criteria characterizing the state of populations, to propose individual diagnostics and prognosis algorithms.

High effectivity of the methods was demonstrated on the examples of diagnostics and prognosis of some low-immunogenic human cancers based on the immuno-cytofluorimetry measurements of the differentiation antigens expressing on the lymphocytes in the blood (abroad panel of monoclonal antibodies was used). It seems

that our algorithms will make an adequate tool for analysis, classification, monitoring and prognosis for a lot of complex ecological systems.

Free-Radical Status of Human Blood in Diagnostics of Some Pathologies

Mil E.M.

A modern express-method which involves the analysis of EPR spectra of hemocontaining proteins of human blood and determination of free radical content in blood lymphocytes during Duhring's and radial diseases has been developed.

The method was used to observe the changes in free-radical states of human blood elements at the stage when conventional classical techniques showed no changes. This method can be applied in combination with immunochemical techniques of blood analysis. It was successfully tested for liquidators of the Chernobyl accident and tumor-bearing patients. The method can be used to evaluate the effect of ecologically dangerous factors, including radiation and chemical agents, their combined effect on population, and to identify risk groups. The method allows to consider the human health status from the point of view of the content of nitrosile complexes of reduced hemoproteins in erythrocyte membranes as well as the intensity of oxygen radicals signals (OH, O₂) registered by spin trap in blood lymphocytes. It was shown that the intensity of EPR signal of hemic iron is 20-30 rel.units in liquidators (dose of 2-30 Rem), that is much higher than in control (2-10 rel.units). Still higher values were observed in liquidators irradiated by low doses (0.1-2 Rem). The intensity of oxygen radicals formation in blood lymphocytes of liquidators is also 2-3 times higher on the average than in control.

The new hindered phenol substance decreases the lens opacity of rodent cataract models.

Muranov K.O, Polyansky N.B.

The anti-cataract effect of the new chemical substance CATAVIDAN has been investigated. The X-ray induced or the selenium induced cataract in rat and the Cat Fraser mice inherited cataract were used. Lenses were observed and photographed for cataract formation by slit lamp biomicroscopy after midriasis. The microphotographs were subjected to densitometric image analysis to find out the mean density of the cataract.

THE X-RAY INDUCED CATARACT. In three months after irradiation the rats were divided into two groups - experimental and control (first estimate). The experimental group rats were instilled by 1% CATAVIDAN in both eyes daily. The control group rats were instilled by distilled water. The nonparametric Mann-Witney test of the lens opacity has indicated significant difference between experimental and control groups during the following three months. The cataract injury was essentially less in experimental group.

THE SELENIUM INDUCED CATARACT. Fifteen days old rats received a single, subcutaneous dose of sodium selenite. Simultaneously the experimental group received CATAVIDAN intraperitoneously. In five days the nonparametric Mann-Witney test and Chi square test of the lens opacity have indicated significant difference between experimental and control groups.

THE CAT FRASER MICE INHERITED CATARACT. It has been shown that the 1% CATAVIDAN in both eyes daily restrains the cataract formation during two months (P) in the experimental group. After three months the differences of the lens opacity were not significant. After four months the cataract injuries were equal in the experimental and the control groups.

Effect of low radiation doses

Pelevina I.I., Gotlib V.Ya., Konradov A.A.

Low radiation doses cause the decay of cells in tissue culture, however, not immediately after exposure but several (3-4) generations later. It is supposed that a specific effect of low radiation doses is a remote death of irradiated cells descendants, which can result from long existent damages in DNA.

The prolonged radiation at low doses increases cell sensitivity to radiation, cys-platinum, lead salts. Cells exposure to radiation within the 10-km region of the Chernobyl nuclear station (total dose of 0,09-0,4 Gr)

decreases a proliferative activity and results in a remote death observed during 15-20 generations. Radiosensitivity of these cells is based as well.

Identification of risk groups among population.

A new method has been recently proposed and applied to evaluate a human individual radiosensitivity and ability to show an adaptive response to radiation exposures. The comparative examination among residents of radionuclide-polluted and "clean" regions revealed changes in distribution of individual residents by their radiosensitivity and adaptive response.

Complex tests for the estimation of the damage factors effect

Shishkina L.N., Polyakova N.V., Kudyasheva A.G., Zagorskaya N.G.

The lipid peroxidation (LPO) processes have a significant role in the mechanism of the radiation damage of the animals organs and tissues. Steady state of LPO in the norm is due to the physico-chemical system regulating oxidative reactions in membrane lipids. Its parameters are the antioxidative activity (AOA) and composition of lipids, their oxidizability, the conformational transitions in membrane components. This regulatory system contributes greatly to membrane repair after irradiation and other damage factors effect. It's also the basis for protective action of natural and synthetic antioxidants after their effect on biological objects.

The generality of the regulatory behavior of oxidative reactions in lipids of laboratory and wild animals is revealed. This allowed to begin comprehensive investigations of distinctions of cell regulatory systems damage in wild rodents organs which were caught in several regions of Chernobyl A.P.S. zone disaster.

The experimental data obtained point to the duration of disturbance retaining in LPO regulatory system both in organs of mice after acute radiation or low dose radiation under low intensity and in tissues of wild rodents taken from Chernobyl A.P.S. zone disaster.

The own and literature data analysis points to the membrane damage enhancement after low intensity radiation.

The experimental data obtained make it possible to conclude that the LPO regulatory system parameters have high sensitivity to technogenic contamination and may be used as complex tests for the estimation of the damage factors effect.

Low doses of radiation. Effect on biological subjects.

Burlakova E.B., Goloschapov A.N., Smotriaeva M.A., Kruglyakova K.E., Zhizhina G.P.

One of features of up-to-date science is the tendency to studying of boundary effects caused by very weak exposures. Our goal consists in examining of early reactions of mammalian organism on molecular level to low level radiation (LLR).

We are investigating the LLR effect on cell genome and membranes of mice. We have a number of physico-chemical methods, allowing us to detect damages of DNA bases and strand breaks in cell nuclei and DNA second and third structure as well.

The membrane viscosity is studied by spin probes and spin labels which are localized in hydrophylic (proteins) and hydrophobic (lipids) regions.

The effect of gamma-irradiation in doses of 0,6 - 60 cGy on DNA of spleen and blood lymphocytes and membranes of blood erythrocytes and liver cells is studied. In all the cases the bimodal curves "dose - effect" were obtained. The activity of membrane-bound enzymes (acetylcholinesterase, for example) was changed in the similar manner. The dose corresponding to maximal effect was dependent on radiation intensity.

Complex of Biophysical Techniques for Examination of Persons Exposed to Ionizing Radiation

Korman D.B.

A set of tests for revealing the changes in human homeostasis and primarily in antioxidative status of persons exposed to ionizing radiation by biophysical techniques has been developed. The set involves 17 biophysical and biochemical parameters, 16 characteristics of immune status, 7 cytogenetic parameters and periphery blood composition. Great attention was paid to a simultaneous analysis of all the above parameters by multidimensional statistics using a specially developed software.

152 persons were examined, among them 104 liquidators of the Chernobyl accident, 27 persons permanently working with radioactive isotopes, the rest being control (volunteers from the Institute of Chemical Physics).

Preliminary Results

1. Comparison of a number of parameters (in particular, the degree of viscosity of erythrocyte membranes, content of free radicals with q-factor 2.00 in blood etc.) showed a significant difference between the "liquidators" and "control" groups even by mean values.
2. In the "liquidators" group the structure of correlations between the analysed parameters is strongly altered as compared with "control", that means the changes in the interaction between various subsystems of organism and the degree of coordination in their functioning.
3. "Liquidators" showed considerable differences among subgroups depending on time, duration and type of activities in the accident zone.
4. The monthly course of the rehabilitating complex of vitamins according to the methods developed in the Institute improved the biophysical parameters and, hence, restored organism homeostasis in most of the cases.

Study of the mortality from leukemia for the population of the United States: it is probably associated with global radionuclides fallouts.

Mamaeva E.F., Mamaev V.B., Burlakova E.B.

Detailed demographic examination of the mortality from leukemia for the population of the United States in the period from 1950 to 1986 followed by statistical analysis has made it possible to define the two cohorts with the increased risk of mortality for the groups aged in 1953 from 0 to 1 and 54. Conducted study has allowed us to assume, that there is a connection between the appearance of these cohorts and the period of conducting air space nuclear weapon tests, when a large number of people were exposed to additional doses of radiation. The growth in the total mortality rate from leukemia over recent 20 years is presumably associated mainly with the increase in mortality rate in the older age groups and represents remote consequences of the fifties and sixties.

Biochemical changes in rats brain synaptosomes (nerve endings) after exposure of respiratory tract to asbestos.

Molochkina E.M., Dzhaman U.M.

Health hazards associated with asbestos use are well known now. Malignant tumors in respiratory tract are the most dangerous consequence of asbestos fibers action. The important aspect of mechanisms of realization of asbestos hazard action on organisms is its effect on central nervous system (CNS).

We consider lipid phase of neuronal membranes as a universal modulator which contributes markedly to reciprocal regulation of different neuromediator systems. In this respect a special role was established for sum content of such phospholipids as phosphatidylinositol and phosphatidylserine (PI+PS).

Asbestos was administered to Wistar rats intratracheally three times with 1-1,5 mnth. intervals. Some characteristics of brain membranes lipid phase were studied - total lipid, total and individual phospholipids and cholesterol contents, their ratios, rigidity index. Some markedly expressed changes were found in the above mentioned parameters including PI+PS after one, two or three exposures. Some distortions revealed in response of membrane lipids to injection of Fe (as it is free radical oxidation modifier) as compared to normal animals.

Brain membrane functioning as it was judged by membrane-bound acetylcholinesterase activity also changed significantly after asbestos acti

The obtained data witness that asbestos including in respiratory tract influences CNS state, regulation capacities of animal organism and sensitivity to an exposure to of external neuro- and psychotropic factors.

Human photo ecology

Ostrovsky M.A.

During the last decade it has become obvious that light is an important ecological factor, comparable with air, water and other environmental factors. It influences visual functions and skin function and circadian rhythms as well.

In accordance with brightness and spectral content of the illumination, visual system condition and professional activity, the photic environment may be as optimal as even aggressive, far from natural possibility of human eye .

Now the mankind meets aggressive photic environment more often: in high altitude and mountains, some artificial light sources and as influence of ozone hole, and also a light formed by artificial eye medium (sun glasses, IOL, contact lenses) with wrong spectral characteristic.

Photic environment influence may result in appearance of some visual pathologies, decrease of professional activity rate, acceleration of aging changes. It may lead to visual exhaustion, photo injury: photokeratitis, senile cataract, macular degeneration and so on.

In laboratory of physical-chemical basis of reception, Institute of Chemical Physics of the Russian Academy of Sciences, main biological and chemical technical approaches to technical solution of this problem may be done on the basis of fundamental research.

Radiation-induced biochemical changes in blood cells and bronchoalveolar lavage fluid of the people, affected by low dose of irradiation during the Chernobyl catastrophe, discovered by the electron spin resonance method.

Pulatova M.K., Baider L.M., Sharigin V.L., Grobova O.M., Chuchalin A.G.

Electron spin resonance (ESR) technique was used to study the whole blood, blood components and bronchoalveolar lavage (BAL) fluid of patients with lung pathology and liquidators of Chernobyl catastrophe consequences. It was shown that samples of BAL, blood plasma of Chernobyl liquidators have the radical products registered by ESR, the concentration of these products being dependent on the length of work of the liquidators at the 4-th Energy unit of Chernobyl atomic power station. It was shown that these paramagnetic centers are radiation-induced and have melanin-containing nature. The main place of these compound localization were lungs. The melanin-containing free radical products were not discovered in the patients with pulmonary diseases who did not take part in the liquidation of Chernobyl catastrophe consequences.

The method for biomonitoring and estimation of environmental genotoxicity for human

Tronov V.A., Tereschenko D.G., Pelevina I.I.

The single cell gel microelectrophoresis assay (DNA comet-assay) allows to estimate the cell genome breakage and repair induced by genotoxic substances and ionizing radiation both in organism as well as in cell culture. The method is a rapid, simple, visual, sensitive and permits the major DNA lesions (SSB, DSB, ALS) to be measured. The advantages of the method are (1) an extremely low number of cells for study, and (2) the cell-by-cell principle of detection which makes the heterogeneity of the cell population to be obvious; also the fractions of sensitive and resistant cells in studied population can be measured. The method has already been applied with success in biomonitoring of environment, for determination of genotoxicity of chemicals and of delayed effects of their action.

Protection and Sensibilization

Sapezhinsky I.I.

Ozone layer is a natural light filter protecting living organisms from ultraviolet irradiation with wavelengths less than 300 nm. With ozone content decreasing in atmosphere the UV-irradiation intensity within 260-300 nm will increase.

An increased integral intensity of UV-irradiation and shift of short-wave boundary of atmosphere transmittance were calculated depending on ozone content. The radiation dose was shown to increase by 5 times with ozone concentration decreasing down to 70% of the existent level and by 50 times with ozone content decreasing down to 30%. The total ozone disappearance will result in a 500-fold increase of a dose power.

Photochemiluminescence technique was applied to study the photosensibilizing and photoprotective activity of 93 substances, including 55 drugs and vitamins as well as metabolites and dyes.

Sensibilizing action was observed in midocalm, sodium sulfacyl, aspirin, levomycetin. The results were obtained on photosensibilization yield (relative to riboflavine) under monochromatic irradiation with a wavelength 313 nm for some drugs under investigation: midocalm (2.7), psoralen (0.24), pyridoxin (0.07), levomycetin (0.04), furacilin (0.04), sulfacyl Na (0.03), aspirin (0.01).

2. Site monitoring

Cytogenic Monitoring of Environmental Factors Effect on Mammalia Cells

Fomina M.M., Ostrovskaya L.A.

A method of evaluating direct and remote effects of environmental factors on genetic apparatus of mammalia cells is proposed. The method implies the in vivo kinetic studies on changes in chromosome structure of normal (marrow) and tumor cells of animals under the action of biologically active compounds and radiation. The method was successfully used in studying heterotoxicity of chemotherapeutic drugs and radiation in normal and tumor cells of animals. In particular, the systematic investigations on the dependences of "structure-effect" and "dose-effect" types in the series of biologically active compounds of nitrosomethylurea showed the induction of long-term aberrations of chromosomes in tumor cells in the absence of remote damages in normal marrow cells. The positive correlation is observed between the frequency of aberration metaphases registered in a population of tumor cells long after the exposure and antitumor effect of the drugs.

It is registered that chromosomes in tumor cells are rearranged under the effect of antitumor drugs at small concentrations (10⁻⁶ M). The cytogenetic quantitative criteria are supposed to be used for studying potential genotoxicity of damaging agents of chemical and physical nature and predicting their remote mutagenic effect.

Development of New Method of Water Environment Testing for Biologically Active Contaminants at Low Concentrations

Ptitsyn G.A., Ilatovsky V.A., Komissarov G.G.

The principally new concept of the project is in using biological objects (single-cell algae) for express-diagnostics of water environment. This allows analysing contaminants not by separate components, but by their integral action on viability and oxygen exchange as one of its main parameters.

The proposed biotesting technique will allow to solve the following practical problems:

- the quality of analysed water in view of plant viability;
- the degree of integral biological activity of contaminants irrespective of their chemical composition and low concentration;
- the degree of non-compliance of contaminated water with reference samples and a possible nature of contamination.

The preliminary experiments on single-cell algae have shown that under pulse illumination of saturating intensity the kinetics of oxygen generation is reliably affected by biologically active substances in a whole range of physiologically active concentrations. These alterations correlate well with the changes in the rate of cells

growth and division. The registration of the latter by conventional techniques requires at least several days. This new effect is taken as a basis in ecological diagnostics of water environment for biologically active contaminants.

Testing aqueous media for their proteinoactivity

Myshkin A.E., Konyaeva V.S.

A new method of testing aqueous media for their non-specific activity in respect to water-soluble globular proteins, named by us proteinoactivity, has been elaborated. Such an activity manifests itself in cases when an aqueous medium contains sufficient concentration of the chemical compounds capable to interact with the polypeptide chain of proteins but not to directly affect the active center of a protein. As a convenient, easily available, and sufficiently stable protein for testing aqueous media, human oxyhemoglobin has been chosen (although animal oxyhemoglobins could also be utilized). The degree of effect on the protein of the part of chemicals dissolved in a tested medium can be evaluated through measuring the rate of oxyhemoglobin oxidation in this medium, the oxidation reaction proceeding, in particular, after addition of a predetermined amount of potassium ferricyanide.

The proteinoactive compounds comprise those interacting efficiently with thiol groups (heavy metal ions, S-alkylating and S-acylating compounds), with amino groups (aldehydes, ketones, N-acylating and N-alkylating compounds, nitrosation agents etc), with carboxylate groups (inorganic and organic cations), and with hydrophobic segments of protein (detergents).

As a measure of the proteinoactivity the ratio of oxyhemoglobin oxidation rate constants obtained in a tested medium and in the pure water was chosen. A series of examples for the proteinoactivity of various aqueous media is presented below:

Pure water	1.00
10 g/l of sodium chloride	1.25
5 mg/l of mercuric ions	2.00
15 mg/l of lead(II) ions	2.00
100 mg/l of domestic detergents	1.4 - 1.7
Sample of water from Bratsk reservoir	1.13
Sample of industrial waste after double purification (Bratsk)	1.54

The method may be modified by introducing agents softening the protein structure into a tested medium, in particular, by alkalization of a medium. In the latter case there is no need to use any special oxidation agent, because oxyhemoglobin under alkali conditions undergoes a comparatively fast autooxidation reaction. The alkali version of the proposed method is many times (in some instances tens times) as sensitive as the ferricyanide version. In particular, it allows determining the presence of mercuric ions at their concentrations of order of 0.05 mg/l.

The method proposed may be successfully applied in many cases for monitoring aqueous media, especially industrial wastes, being a new useful characteristic in addition to conventional ones. The determination of the proteinoactivity of aqueous media would be particularly advisable in such cases when the nature of pollutants is not established and a rapid integral test for the pollution degree is desirable. The method can also be applied to test the wastes with known pollutant composition, when to determine the concentrations of some pollutants cumbersome methods of chemical analysis or too expensive devices are needed.

Development of integral tests of ecosphere state.

Khrapova N.G., Pariiskii G.B.

1. Dependence between the natural antioxidants content in some grasses of middle zone and conditions of their growth is found. Observed effects can be used as a basis of the phytointicator method of the ecosphere state control.

2. Ability of the polymer hydroperoxides for induced decomposition under influence of nitrogen and sulphur oxides is observed. Future progress of this investigation will be pointed at the tests development for evaluation of the total ecosystem state which reflects the cooperative action of pollutants of certain classes.

Laser-based ultra high-sensitive detection of poisonous organic impurities in water and food supply.

Popov A.A.

The research of water purification techniques is accomplished in collaboration with the Laboratory for Laser Diagnostics headed by Prof. S.Alimpiev of General Physics Institute. This Laboratory develops the novel laser-based ultra high-sensitive methods for the detection of tap water impurities:

1. Laser induced fluorescence of organic contamination of ultrapure water based on the detection of fluorescence spectra of solved organics under irradiation by a pulsed UV laser radiation (excimer laser with 193-308 nm wavelength). The results of experimental study (Alimpiev S.S., Nikiforov S.M., Simanovskii Ya.O., Kulberg A.Ya., Laser- induced fluorescence of bio-organic impurities in water. In: "Optical monitoring of the environment: CIS Selected papers", Nicholay N.Belov, Edmund I.Akopov, Eds., Proc. SPIE 2107, 266-273, 1993) have demonstrated that the high sensitivity of the laser-induced fluorescence technique makes it possible to detect the appearance of organic compounds produced by contaminating microflora in the samples of ultrapure deionized water during their storage.
2. Laser assisted mass spectrometry of organic molecules solved in water based on laser ablation of frozen water samples in vacuum and time-of-flight mass spectrometry of impurities. This technique was shown (S.Alimpiev, et all, Laser mass spectrometry of a frozen water matrix in environmental analysis, The Analyst Vol.119, p.579, 1994; Analytical Chemistry, 1994, to be published) to be used for the high-selective detection of poisonfull organic impurities (phenol, dioxin, ...) in water with the detection limit down to 1 ppt level.
3. Laser photoacoustic detection of microparticles in water based on registration of acoustic signal from microparticles of submicron size (less then 0.1 m) under irradiation of water by a strong pulsed UV laser beam. It was shown (Alimpiev S.S., Simanovskii Ya.O., Egerev S.V., Pashin A.E., Laser- induced cavitation as a tool for detecting microparticles. In: "Optical monitoring of the environment: CIS Selected papers", Nicholay N.Belov, Edmund I.Akopov, Eds., Proc. SPIE 2107, 293-302, 1993) that the laser-induced cavitation mechanism of optoacoustic conversion is optimal for individual particle detection and provides the detection limit of about 1 ppt for insoluble impurities in water.

Electron spin resonance method of biological dosimetry: an influence of enamel structure and admixture of dentin on dose estimation.

Serezhenkov V.A., Klevezal G.A., Domracheva E.V., Moroz I.A., Vanin A.F.

Electron spin resonance (ESR) spectrums of deciduous teeth enamel and permanent teeth enamel irradiated in vitro and in vivo were investigated. Mechanical treatments used for obtaining enamel chips appeared to have no influence on radiation induced ESR signal. There was no significant difference on radiation induced ESR signals between samples of enamel from back wall, front wall and occlusal surface of both permanent and deciduous teeth irradiated in vitro with ^{60}Co gamma-rays or X rays ($E=0,1$ MeV), and between irradiated in vitro enamel of permanent and deciduous teeth. When dose of in vivo received radiation was estimated using regressions of relative radiation induced ESR signal against dose of radiation plotted previously (Brilliant et al., 1990), dose estimations for two teeth of the same person (11 comparisons of teeth obtained in the normal course of dental practice from residents of Chernobyl region and Cheljabinsk region) revealed no significant difference. It was found that admixture of dentin decreases the dose estimation: 50% dentin admixture gives 3,2 times decrease of amplitude of ESR signal.

3. Alternative processes and materials

A new ecologically pure method of sulfurous compounds removal from fuel gases.

Blumberg E.A., Skibida I.P.

To solve the important ecological problem of gases purification from hydrogen sulfide and sulfur dioxide a one stage process of H_2S and SO_2 liquid-phase oxidation by air oxygen in water SO_2 solution in the presence of homogeneous catalyst is proposed.

The following makes this technology unique:

- absolute ecological safety,
- combining of gas purification with trade product - sulfuric acid manufacturing,
- one-stage type of process and high productivity (more than $1000 \text{ kg/m}^3 \text{ xh}$ of sulfuric acid)
- no H_2S and SO_2 concentration limits (the gas which is to be purified can contain from 0,1 to 100%),
- sufficient decrease of sulfuric acid operational cost.

New extrusion technology for processing of solid organic wastes (plastics, rubbers, polymer composites, synthetic leather, textile etc.)

Gol'dberg V.M., Vol'fson S.A., Nikolskii V.G.

Multipurpose extrusion method is developed for obtaining of powders from wastes of different solid organic materials. Method demands lower expenditure of energy then conventional ones and offers to powder such materials which can't be powdered using other methods.

The method gives a one-of-kind opportunity to obtain homogeneous powders from compounded wastes. Resulting powders have unusual microstructure and well-developed surface. These powders can be used as fillers, components of polymer blends or for coating producing.

The ways to decreasing wastes of polymeric materials. Creation of self-decomposing polymeric materials.

Popov A.A.

The results of basic investigation of the scientists of the Department in the field of kinetics and mechanisms of various types of polymer degradation: thermal photoinitiated, hydrolytic etc. self-decomposing polymers are being designed. These polymers are designed for predetermined service life. The methods of accelerated testing of destruction kinetics of these polymers which either contain the self-decomposing units in the main chain or contain the additives accelerating their bio- photo- and hydrolytical destruction or weathering are worked out.

The use of recovered polymeric materials

In Department of Chemical and Biological Processes the studies on creation of new polymer-based composites are being conducted. In these studies the technology of polymer blends preparation is developed, the structure and properties of two and three-component rubber blends and co-vulcanizates are studied. The studies are aimed to creation of new materials with predetermined properties.

One of the directions of this study is development of the ways of the use of recovered polymeric materials. In these works the polyethylene-polypropylene blends, the blends of polyethylene with ethylene-propylene-diene copolymer, with polysiloxane oligomers and butadiene-styrene thermoelastoplasts, and some others are studied.

The effect of degree of destruction on the properties of blends and composites is established. Technologies of preparation of ozone- oil- and frost- resistant rubber based on blending of nitrile rubber with polyvinylchloride and of some other composite materials were developed.

Alcolanes.

Skibida I.P.

New original - ecologically pure and very effective - method of producing of the fluoro-substituted hydrocarbons (Alcolanes - technical name) by oxidation of alcohols $\text{H}(\text{CF}_2\text{CF}_2)_n\text{CH}_2\text{OH}$ ($n=1-6$) with molecular oxygen. Yield of Alcolanes is about 95%, selectivity up to 98%.

Alcolanes are effective in the fire putting out. The fire putting out concentration depends on the nature of burning material (wood, rubber, paper, ethanol, heptane). At the Alcolanes concentrations of $450-650 \text{ g/m}^3$ in closed volume the fire dies out instantaneously.

The toxicity of Alcolanes is negligibly low (close to that of inert gases).

New Generation of Ecologically Safe Regulators of Plant Growth

Zoz N.N.

New regulators of plant growth (RPG) combine such properties as high activity, wide spectrum of action and ecological safety. Though being used at low concentrations, the regulators increase crop yield, plant resistance to stresses (diseases, droughts, frosts). Fruit treated by the regulators are better preserved under storage. The new RPG also show a radioprotective effect and decrease a spontaneous mutation rate in many agricultural plants.

PVC employment for dyes sorption from aqueous solutions in the presence of tertiary ammonia salts.

Davydov E.Ya., Vorotnikov A.P., Pustoshnyi V.P.

Catamine AB gives complexes insoluble in water, possessing high affinity to PVC. Optimal conditions (temperature, Catamine concentration, PVC quantity) are established for water purification from different textile dyes of anionic type on the base of this result.

Biological control with antagonistic bacteria against phytopathogenic bacteria and fungi

Izmailov Z.F., Terentiev M.A., Korotkov E.V., Chernin L. S.

Center "Bioengineering" of Russian Academy of Sciences, University of Samarcand Uzbekistan Republic, Institute of Chemical Physics of Russian Academy of Sciences. Fax: 7-095-135-0571, 7-095-938-2156

Diseases caused by soil-born bacteria and fungi are widely spread among agricultural important crops (i.e. cereals, fruits, grapevine, potato, cotton, tomato, leguminous) and ornamental plants. Depending on the type of plant, disease, pathogen, environmental conditions and agrotechnique methods the economic detriments from these diseases can be very significant owing to yield decrease up to 50 and more percents. Integrated control of soil-born plant pathogens should be based on combination of several approaches, including: i) production and introduction in practice of new chemical compounds which are able to overcome resistance of plant pathogens to many chemical pesticides used before; ii) development of new technology of propagation of pathogen-free materials; iii) development of the disease resistant cultivars, including methods of plant genetic engineering; iv) development of biological control methods.

The main purpose of the project is the development of new microbial products for biocontrol of plant diseases which would mainly overcome the demerits of the products available at present. This will be done by creation of products in which direct and indirect effects of plant beneficial bacteria associated with plant rhizosphere and/or phyllosphere will be used in composition. In addition the project will deal with the search and characterization of new broad host range antibiotics produced by soil bacteria and development of their practical application for biocontrol of plant diseases.

The methodology of the work will include :

- i) screening of soil bacteria isolated from parts of plant affected by diseases or from the soil around them for antagonistic activity against various phytopathogenic bacteria and fungi in vitro;
- ii) taxonomic identification of selected strains;
- iii) selection of antagonists which are able to root colonization and persistence in sterile and infected (naturally and artificially) soils;
- iv) examination of isolates for plant-growth-stimulators production;
- v) checking of selected strains on pathogenicity for animals and plants and other side effects;
- vi) study of antagonistic effect of the strains in vivo by greenhouse assays on provocative phones, different environmental condition and doses of candidate bacterium;
- vii) study of mode of pathogen suppression;
- viii) formation of optimal composites contained strains with direct and indirect plant beneficial effects;
- ix) checking for best mode of practical utilization of new composites for biological control of crops in greenhouse and field conditions and prevention of postharvest diseases;
- x) optimization of fermentation of selected strains;

- xi) isolation of compounds with antibiotic activity and their physio-chemical analysis;
- xii) characterization of biological properties of isolated compounds by use of antibacterial, antifungal, antiviral, cytotoxicity and mutagenicity assays;
- xiii) localization and molecular cloning of genes determining the activity;
- xiv) development of the newly found antibiotics for commercial use.

Environmental engineering. Ozonization

Popov A. A.

I. Water quality

The kinetics and mechanisms of chemical reactions of ozone with saturated and unsaturated hydrocarbons, oxygen-, nitrogen- and chlorine-containing organic compounds, surface-active agents dyes, and polymers were studied in the Department. The ozonization technology for purification and disinfection of water has been developed basing on these theoretical investigations. In combination with other methods (sorptional, membrane, electrochemical and biological technologies) the water quality improvement regime has been optimized.

II. Dioxinless technology

Dioxin and dioxin-like compounds are formed in paper production and in some chemical processes involving chlorine. The ecologically clean technology of bleaching of cellulose has been developed in the Department. Using ozone instead of chlorine for the oxidation of lignine excludes the synthesis of chloroorganic compounds.

Method of substituted w-hydroperfluoroalcanes obtaining .

Skibida I.P., Sakharov A.M.

A method of obtaining substituted w-hydroperfluoroalcanes of general formula: $R(CH_2CH_2)_nH$ where $R = H, COOH$, $n = 1-10$ consists in oxidation of w-trihydroperfluoroalcohols by gaseous oxygen or oxygen-containing gas in the presence of copper-containing catalyst and an alcali agent in the medium of an organic solvent with subsequent extraction of the desired product.

Urea and phenol formaldehyde foams with improved properties for environment

Aseeva R.M., Nechayev P.P.

The methods for decreasing of toxicity and smouldering activity in phenol and urea formaldehyde foams are developed. Small amounts of additives of substances which have influence over polycondensation reactions, thermo-oxidation and hydrolysis of polymers are being taken for reducing formaldehyde or phenol emission at the production and the using of these foams. The approach permits to suppress smouldering and also to improve other indices of foam fire safety.

4. Environmental engineering

Decomposition of cyanides in the industrial waste water of gold extracting enterprises.

Burlakova E.B., Gumargalieva K.Z., Dolinkevich A.A., Piscarev I.M., Rylova A.E., Sevastianov A.I.

A method of purification of waste water by using a carrier of electric charge which is formed in the process of plasmachemical reaction is recommended. Authors of this method have found the optimal conditions of decomposition of cyanide solved in water on the surface and in the volume of liquid media.

Wastes Cleaning and Regeneration

Kasaikina O.T. and her group

Regeneration and cleaning of industrial, motor and transformer oils. The main task is to regenerate out-of-service oils, to bring up technical and organoleptic parameters of regenerated oils to standard and commercial. Technological conditions of oil regeneration can be varied depending on oil contamination extent, presence of mechanical impurities, and acid number. The adsorption stage of oil cleaning was modified by optimizing the system of solvent and adsorbent regeneration. It made production of light oils with low content of water and hydrophilic components in compliance with standards possible. The advantages of the proposed algorithm of cleaning are the reduction of energy losses by monitoring of the initial oil quality and ecological safety due to the closed cycles for solvents and sorbents and wastes utilization. The proposed cleaning system uses the basic technological scheme operating at some plants and oil tank farms (for example, the Yaroslav oil handling terminal) and is equipped with mixers and evaporators providing closed cycles for solvents and sorbents regeneration.

New sorbent based on wastes from microbiological industries

Mar'in A.P.

New sorbent consisting of the wastes from microbiological industry and of 90-99% of active mineral binder has been proposed for purification of contaminated water (industrial wastewater). The sorbent effectively removes ions of heavy metals, including barium, copper, lead, nickel, zinc, uranium, plutonium, and also of cesium. Grain-shaped sorbent is heavier than water and has low hydrodynamical resistance. The sorbent consists of easily accessible low-cost materials.

The sorbent possesses high efficiency at both high and low contaminant concentrations.

The sorption capacity for uranium ions reaches 0.4-0.5 grams per gram of the sorbent.

Developed by A.P. Mar'in & Yu.A. Shlyapnikov (Institute of Chemical Physics of Russian Academy of Sciences) and E.P. Feofilova & V.M. Tereshina (Institute of Microbiology of Russian Academy of Sciences)

The Certificate of Authorship SU N 1823397 from October 12, 1992.

Determination of pesticides residues in crops using capillary gas-liquid chromatographic-mass spectrometry.

Koversanova E.V., Barinova E.S., Brodskiy E.S.

A gas-liquid chromatography-mass spectrometry (GLC-MS) for determining of 11 organochlorine pesticides and 9 synthetic pyrethroids residues in crops is described. The minimum detectability of pesticides was 0,2-1 ng.

Wastes Cleaning and Regeneration

Kasaikina O.T. and her group

Choice of inhibitors preventing regenerated dyes from thermodestruction. Dyes used in textile production are purchased from abroad and rather expensive. Therefore, of great importance is the problem of wasteless dyeing and, in particular, dyes withdrawal from waste water and their further use for dyeing of various materials. According to the technology developed by the chair of HMC in the Chemical faculty at the Moscow State University dyes are withdrawn from waste water in the polymer-SAS-dye complex which is supposed to be applied for dyeing of polymer materials. The uniform distribution of dye over the material bulk is achieved by introducing the complex into polymer melt. The latter needs a relative stability of dyes at high temperatures. The data on thermo- and chemostability of some individual azo dyes applied in textile industry and their complexes with water-soluble polymers and SAS were used to analyse the causes of thermodestruction of dyes in complexes. Recommendations on ways of increasing their stability at high temperatures were given.

Effect of Ultralow Doses of Biologically Active Substances on Plants

Bogatyrenko T.V

The effect of various chemical substances (herbicides, growth-stimulators, antioxidants, peroxides) on the growth of cultivated cells in higher plants within a wide concentration range from 10^{-4} M to 10^{-17} M is studied. The following conclusions are made:

1. All substances under study show a reliable effect, with decreasing concentrations down to 10^{-15} - 10^{-17} M.
2. The equal effects are observed at concentrations varying by hundreds times.
3. The active pesticide concentration can be reduced by 100 times via modifying vegetable cells sensitivity by ultralow doses of BAS.

Hydrolytic stability of pesticides.

Nechaev P.P., Kamzolkina E.V., Mukhina O.A., Kulyova S.S.

As the main criteria of ecological safety of pesticides their ability to quick decomposition after using is to be considered. An easy method of hydrolytic stability of pesticides evaluation is proposed.

Modification of behavior of animals by air pollutants from ageing polymeric materials

Vasil'ev R.F.

Recently we found that volatile (presumably radical-like) antioxidants which have been shown to be evolved into the air from ageing polymers influence the level of excitability of the central nervous system and, further, psychoemotional behavior of test animals. The experiments included testing of a representative number of mice and rats and using an original chemiluminescence technique for monitoring the antioxidant concentration.

As polymeric fabrics, parts, waste, etc. are now usual components of the environment, we suggest that this novel phenomenon should be considered as an ecologically important, long-term and, possibly, hazardous factor, especially in industrial areas, near the roads with heavy traffic and inside/near the plants processing rubbers, resins, other polymeric materials.

Synergism of Radiation and Sodium Nitrate (EPR Studies on Combined Action of Sodium Nitrate and Total Radiation of Animals)

Kuropteva Z.V.

Electronic paramagnetic resonance (EPR) was applied to study the changes in metabolism of tissues of animals organs (liver, kidneys, spleen, brain, heart and blood) produced by administration of sodium nitrate, radiation and total radiation 30 min after administration of sodium nitrate, radiation dose being 4 mg/100 g. It is shown that post-radiation of animals treated with sodium nitrate intensifies the consequences of the exposure to sodium nitrate according to the following parameters:

- 1) an increased methemoglobin content enhancing hypoxia and more rapid methemoglobinemia;
- 2) a higher content of nitrosile complexes Hem-No and, hence, an increased content of exogenous nitrogen oxide;
- 3) a higher degree of inhibiting the hydroxylating system of endoplasmatic reticulum involving cytochrome P-450, which can result in strong damages of tissues metabolism since cytochrome P-450 participates in biotransformation of various compounds in organism, such as substrates of endogenous origin (synthesis and decay of cholesterine, steroid hormones, fat acids, prostaglandines) and xenobiotics (drugs, pesticides, carcinogens).

Application of growth regulator AMBIOL for raising of the productivity of plants and animals.

Stolyarova L.G., Kuznetsov Yu.V.

Ambiol is an antistress low toxic antioxidant of complex effect, possessing antimutagenical and radioprotective properties. Application of ambiol for raising of the productivity of plants is ecologically safe, as it limits oneself to a single presowing treatment of a planting material (corn, sunflower, wheat, cucumber etc.) in low doses. The consumption rate with semi-dry method is 0.01-1.0 g per 1 t seeds. A double pre-harvesting (50 mg/l) and a single post-harvesting (1 mg/l) spraying of apple-trees and fruits with an aqueous solution of the ambiol allows to prolong a keeping period of apples in a usual atmosphere till March.

Also ambiol has good effect on fertility system of animal's organism as well. Besides it compensates a negative influence of increased quantity of nitrates in forage of animals.

6. Environmental and human rehabilitation

Antioxidants at Low Doses for Afforestation in Polluted Regions

Burlakova E.B., Apasheva L.M., Dmitriev I.B., Komissarov G.G., Dukharev V.A.

Vast territories withdrawal from land tenure is a usual consequence of ecological disasters. Afforestation is a reliable way to rehabilitate the damaged lands. This process can be optimized by presowing and out-of-root treatment of coniferous seeds and seedlings by antistress drugs, antioxidants (AO) at low doses.

The Chemical and Biological Department (head-Prof. E.B.Burlakova) developed some compositions based on AO and polymers-incrustators produced from vegetable wastes. The compositions (polymer+AO) are successfully used for grafting precious species of trees. The compositions decrease AO content, increase efficiency and time of action, allow incorporating other necessary substances in the incrustators. Adaptogenic properties of AO were analysed at the increased level of radionuclide content using pine species most spread in the territory (the 30-km region of the Chernobyl nuclear station). The earliest stage of pine onthogenesis is most sensitive to radiation. Growing pine seeds collected in the Chernobyl region and seedlings were treated by AO. The growth of control seeds was stimulated beginning from seed sprouting. The extent of sensitivity to AO varies in different seeds and may be related to a certain set of enzymes specific to a certain family. Combined with a high radiation level the adaptogenic action of AO is most effective at the early stage of pine onthogenesis. AO application for rehabilitation of damaged lands by their afforestation allows improving seed sprouting by 30-40 times, increasing total biomass by 15-20 times up to wood maturity and preserving genetic diversity of plants after ecological disasters.

New biotechnology of the soil fertility recovery

Vasil'eva S.V., Krasavin A.P., Kataeva Y.V.

New biotechnology for efficiency increasing and accelerating of soil fertility recovery after mining works in the coal industry as well as in some others. This biotechnology makes possible to solve different problems simultaneously - of environmental safety, social, of additional food sources.

The proposed biotechnology is based on research in genetics and biochemistry of the soil microorganisms and appropriate technical manipulations. An application of the special selected microorganisms mobilizes the potential fertility of C-containing substrate and stimulates accumulation of organic substances in it.

On the basis of this biotechnology more than 3000 acres of infertile soils in Russia were recovered in the last 5 years. The new biotechnology is faster, safer and more effective as compared to the traditional ones. This new biotechnology is very cheap, because it doesn't require special expensive equipment.

Neyfakh E.A. and Ivanenko G.F.

A number of technogenic factors of chemical and/or physical nature which effect unfavorably health of multimillion contingent in enhancing degree has been well studied. The majority of such factors has high carcinogenic, mutagenic and/or toxic properties. They attack and disturb vitally important biostructures and metabolism with free radical mechanisms. The latter permits us to develop and introduce into practice the simple methodology of biochemical monitoring for so-called "human free radical pathologies". It is based on high-sensitive simultaneous analysis of the cascade of relatively stable lipoperoxide catabolites (LPC) and essential bioantioxidants (BAO) as regulators for lipoperoxidation. An example of such approach is our reports devoted to diagnostics of lipoperoxide pathologies and their successful correction for people who obtained low and middle radiodoses as a result of taking part in liquidation of the Chernobyl catastrophe or children living in touched areas. It was found that blood primary LPC (dienes, hydroperoxides, ketodienes) and secondary LPC (carbonyls, MDA) were greatly in excess of normal diapasons. Exhaustion of BAO systems (vitamins E and A, GSH) were found for touched population. BAO deficits and their couplings were growing along with increasing of radiodose loads. It was shown that the sum BAO deficit is in positive correlation with radioloads. The "A/E index" (defence of retinol with tocopherol) fell back to half of the normal level for near 80 Rem radioload.

The similar situation was shown for children (from neonates up to six years old) from touched regions differing in radionuclides pollution ($1-20 \text{ Cu/km}^2$). The contingents with retinol and /or tocopherol deficiencies and LPC hypertrophies were evaluated. Such deviations from norm levels diapasons and their combinations were more significant for more contaminated regions. LPC levels are correlated positively with computed individual radiodose loads (IRL). It is important that IRL for touched mothers were correlated negatively with tocopherol levels for their kids.

Shifted LPC and BAO levels were normalized with the peroral BAO therapy if radioloads did not exceed 80 Rem and 50 Rem correspondingly. For higher radioloads the BAO therapy permitted to improve all studied levels.

The used correction scheme together with BAO and LPC monitoring is recommended as an effective enhealthening arrangement for contingents touched with radioecologic catastrophes.

7. Certification

Co-ordinative Center POLYCERT Limited Liability Partnership

Karpukhin O.N.

Research, production, development, testing and certification of polymeric materials and articles. Special software development for these purposes.

Polycert is included in the certification system of chemical production CEPROChim. POLYCERT demonstrates the following items:

- Polycert certification system which ensures certification of materials and production to service life;
- Integrated Computerized System KINETIC TRUNK for processing of kinetic tests data and materials properties forecasting;
- Complex of technologies and recipes for special-purposes materials of production and samples of such materials;
- Optical materials designed with participation of Polycert specialists and articles of ophthalmological purposes made of these materials.